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ABSTRACT

A proper understanding of the role of culture in development can make a significant contribution to the development of theory and offer a more certain guide to practice than current theories afford. Three frameworks for interpreting the influence of nature and nurture on individual development assign biological and environmental factors a direct role in shaping the individual. An alternative framework models a view of the cultural mediation of biological inheritance and universal features of the environment. This framework is discussed in terms of two forms of "structuration processes" that characterize human development: context and modularity. Context is thought of as a cultural source in the "structuration" of behavior, while modularity indexes a model of the structure of mind which posits domain-specific modules loosely linked by a "central processor." Interposed between modules and processor is a level of organization thought to be roughly equivalent to cultural context, which selectively recruits different kinds of modular inputs depending on culturally accumulated constraints. This picture of the interaction of context and modularity is elaborated in a discussion of the temporal relations between the two forms of structuration in the contexts of the microtime of individual development and the macrotime of evolutionary history. (RH)

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Context, Modularity, and the Cultural Constitution of Development

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Despite intensive research devoted to the issue over the past century, psychologists appear to have made relatively little progress in resolving a variety of fundamental disputes that hinder the formulation of a generally acceptable theory of human development. These disputes continue to center on a core of dichotomous distinctions around which scientific and public opinion oscillate according to the fashion of the day.

Even though it is the almost unanimous opinion of contemporary psychologists that development emerges out of a continuous interaction between genotypes and their environments and that the individual and society mutually constitute each other, it is my strong impression that developmental psychology has not yet found a synthetic framework that would allow us to put such dichotomies to rest once and for all. I cannot hope to provide such a synthesis in the course of this brief paper. However, I would like to make a contribution to this task by

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proposing that psychologists rethink a category of phenomena which, in my opinion, has been misunderstood and misused over the entire history of scientific psychology, the category of **culture**.

I will begin by summarizing the dichotomous views of classic theories of development and then propose a conception of culture which holds promise for uniting them within a single, synthetic framework. I will then apply this conception to my own interpretation of social context and its role in development. I will attempt to select my examples from a sufficiently broad range of age periods and developmental phenomena to make plausible my claim that proper understanding of the role of culture in development can make a significant contribution to understanding what is unique about human sociality and offer a more effective guide to practice than current theories afford.

Insert Figure 1 about here

Three Classic Theories and a Tripartite Alternative

Figure 1 contains a schematic representation of the three positions that have dominated theorizing about development in this century, along with a fourth approach in which the category of culture has been added as "third force" (Borrowed from Cole and Cole, 1989). The uppermost line in the figure represents the view articulated in the first half of this century by Arnold Gesell, according to which endogenous factors largely set by phylogeny dominate development. For example, Gesell wrote that

> Environment... determines the occasion, the intensity,

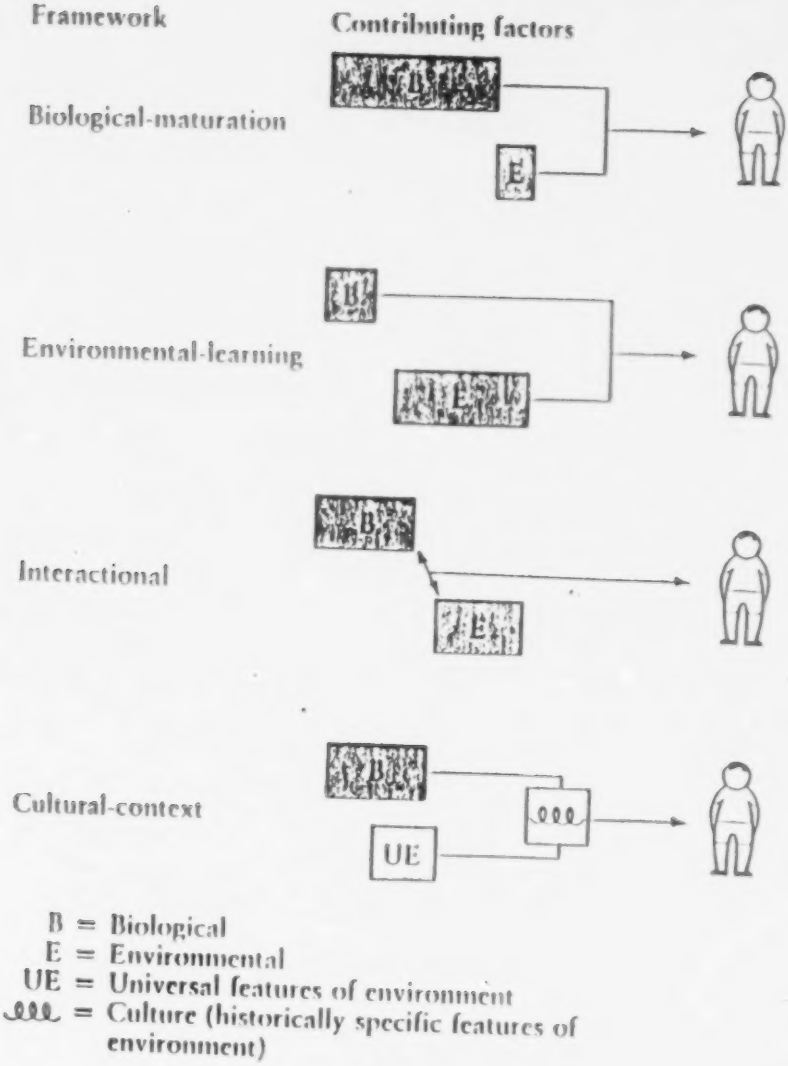

FIGURE 1. *Four frameworks for interpreting the influence of nature and nurture on individual development. In the first three frameworks, biological and environmental factors directly shape the individual. In the fourth, the cultural-context framework, biological inheritance and universal features of the environment act through the medium of culture.*

> and the correlation of many aspects of behavior, but it does not engender the basic progressions of behavior development. These are determined by inherent, maturational mechanisms (1940, p. 13)

Elsewhere he added,

> Neither physical nor cultural environment contains any architechtonic arrangements like the mechanisms of growth. Culture accumulates; it does not grow. The glove goes on the hand; the hand determines the glove. (1945, p. 358)

Gesell's perspective, although enormously influential, suffered a period of eclipse among academic theorists in the 1960's and 1970's. However, at present there is a significant revival of interest in innate constraints on development, albeit one that minimizes attention to general endogenously stimulated changes in favor of domain specific changes (Brown and Gelman, 1985; Carey, 1985; Fodor, 1983). I personally find Gesell's basic theoretical writings a constant source of interesting ideas and I will return to discuss this approach in terms of the concept of modularity later in this paper.

The polar opposite view, that the environment provides the major impetus for developmental change, is represented in row two of Figure 1. An extreme version of this view was put forward by J.B. Watson in the following famous assertion:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select-doctor, lawyer, artist, merchant-chief, and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors (1930, p. 104).

Although modern psychologists are likely to disapprove

of Watson's flamboyant style and consider his position somewhat exaggerated, his emphasis on the dominant role of the environment (and implicitly at least, the social environment of "trainers") in shaping development continues to have many adherents (e.g. Bandura, 1986; Zimmerman, 1983).

Jean Piaget, perhaps the most influential developmental theorist of the 20th century, argued forcefully for the equal weight of endogenous and exogenous factors in development, a view which is schematically presented in the third line of Figure 1. On the one hand, he argued that

> Mental growth is inseparable from physical growth; maturation of the nervous and endocrine systems, in particular, continue until the age of sixteen (Piaget and Inhelder, 1969, p. viii.).

At the same time, Piaget, like those who adopt an environmental-learning perspective argued that the role of environmental input goes well beyond determining the occasioning, intensity, and correlation of behavioral aspects of development.

> The human being is immersed right from birth in a social environment which affects him just as much as his physical environment. Society, even more, in a sense, than the physical environment, changes the very structure of the individual...Every relation between individuals (from two onwards) literally modifies them... (Piaget, 1973, p. 156).

Although they differ in the weights that they assign to the phylogenetic constraint or ontogenetic experience, the interactions posited by adherents to each of these positions take place between two juxtaposed forces and in this sense, they remain dualistic (both Gesell and Piaget implicitly suggest that the environmental side of the equation can be partitioned, into

"culture" or "social factors" versus the physical environment, but these distinctions are not developed).

The fourth row depicts what we have termed a "cultural," "cultural historical" or "cultural context" view of development (Cole and Cole, 1989; LCHC, 1983, Luria, 1928). According to this approach, the two factors labelled "biology" and "the environment" in the previously described approaches do **not** interact directly. Rather, their interaction is mediated through a third factor, culture, which, has undergone a process of historial development and which conditions the interaction of the two factors that underpin the previous approaches. Note especially that in this fourth view:

1. The environment is partitioned into two classes, universal features such as the influence of gravity, the presence of oxygen in the atmosphere, etc.) and historically specific features of the environment labelled **culture**;

2. Culture does not stand in a dichotomous relationship to biology; rather the creation and use of culture is taken as **the** distinctive biological characteristic of our species. Put differently, the form of our nurturing **is** our nature.

Needed: A Psychologically Relevant Conception of Culture

The task of establishing my contention that culture constitutes human development is seriously hampered by the fact that are severe conceptual disagreements about the nature of culture even among anthropologists, for whom the concept is central. As Super (1987) has noted, these definitions seem to

vascilate between omnibus characterizations of culture such as E.B. Tylor's early definition of culture as a complex "which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society (1871, p. 1). and the presumably narrower notion that culture is a society's system of shared meanings. Psychologists who seek "the" correct definition within this set are certain to be disappointed. A well known monograph by Kroeber and Kluckholn (1952), for example, offered more than 250 definitions and the number has certainly grown considerably since that time!

Since appeal to the "generally accepted" (let alone "correct") definition of culture is almost certainly a hopeless enterprise, I will take the alternative tack of adopting a conception of culture which can be considered respectable if not universally adopted by modern anthropologists and which affords the kind of synthesizing framework that I am seeking (See Shweder and LeVine, 1984 for an extensive discussion of this issue by anthropologists of varying persuasions, and Lave, 1988 for an anthropologist's view of the shortcoming of both anthropological and psychological approaches to the study of culture and psychological processes).

The conception of culture which my colleagues and I have been advocating can be approached from several directions. First we can note that the concept, culture, occurs in the discipline of biology as well as in the social sciences. For example, we are accustomed to think of a "tissue culture,"

a special **medium** within which cells of the appropriate kind will proliferate. Culture, understood in this manner, is the medium within which the two "factors" of traditional developmental theories interact to produce development. (In this sense, as Jaan Valsiner (1988) has pointed out, culture cannot be considered an independent variable).

For many years my ideas about the role of culture in development have been influenced by the writings of Soviet psychologists associated with the cultural-historical school of L.S. Vygotsky, A.R. Luria, and A.N. Leontiev (See Cole, 1988, for a summary of my interpretation of this line of thought in relation to earlier cross-cultural work by myself and my colleagues). Central to their formulations (and a good deal of anthropological theorizing) is the notion that human beings live in an environment transformed by the artifacts of prior generations, extending back to the beginning of the species (Ilyenkov, 1977; Geertz, 1973; Sahlins, 1976, Wartofsky, 1979). The basic function of these artifacts is to coordinate human beings with the physical world and each other. Cultural artifacts are simultaneously ideal (conceptual) and material. They are ideal in that they contain in coded form the interactions of which they were previously a part and which they mediate in the present. They are material in that they exist only in so far as they are embodied in material artifacts. This principle applies with equal force whether one is considering language/speech or the more usually noted forms of artifacts which constitute material

culture. As the Amerian anthropologist, Leslie White expressed the relationship,

> An axe has a subjective component; it would be meaningless without a concept and an attitude. On the other hand, a concept or attitude would be meaningless without overt expression, in behavior or speech (which is a form of behavior). Every cultural element, every cultural trait, therefore, has a subjective and an objective aspect (White, 1959, p. 236).

The special characteristics of human mental life are precisely those characteristics of an organism that can inhabit, transform, and recreate an artifact-mediated world. As Soviet philosopher Evald Ilyenkov, put it "the world of things created by man for man, and therefore, things whose forms are reified forms of human activity... is the condition for the existence of human consciousness (1977, p. 94)." The special nature of this consciousness follows from the dual material/ideal nature of the systems of artifacts that constitute the cultural environment--human beings live in a "double world," simultaneously "natural" and "artificial."

The characteristics of human psychological processes that accompany this view of human nature as creat-d in culture-as-historically-accumulated-systems-of-artifacts was described in particularly powerful language by White, who wrote:

> Man differs from the apes, and indeed all other living creatures so far as we know, in that he capable of symbolic behavior. With words man creates a new world, a world of ideas and philosophies. In this world man lives just as truly as in the physical world of his senses... This world comes to have a continuity and a permanence that the external world of the senses can never have. It is not made up of present only but of a past and a future as well. Temporally, it is not a succession of disconnected

> episodes, but a continuum extending to infinity in both directions, from eternity to eternity (White, 1942, p. 372).[1]

This basic perspective, which I refer to as a cultural theory of mind (Cole, 1990), is often represented as a triangle, in which the vertice is a mediating artifact and the remaining points are subject and object (See Figure 2)(For an early statement of this perspective containing such a triangle, see Vygotksy, 1928. In such a repesentation, the "first" world is

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Figure 2

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conceived of as the "direct" link between subject and object, while the "second" world is given by the indirect pathway through the mediator the structure of which is continuously being modified by its participation in the patterns forms of activity embodied in culture.[2] Note, as the Soviet cultural-historical theorists emphasized, that mediators (artifacts) enter into the organization

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[1] While it would be an error, in view of recent decades of work on proto-cultural features among primates (Goodall, 1986, Kawamura, 1963; Premack & Premack, 1983; Tomasello, 1989), to overstate the discontinuities between homo sapiens and other species, I concur with Robert Hinde (1987) in believing that these phenomenon do not imply culture in the way in which human beings have culture.

[2] Common usage of the term, mediation, tends to disguise its etymological link to the notion of indirectness. The underlying semantic relations are revealed by noting that a synonym for direct is immediate; indirect is an antynomym for direct; the antonym for immediate is mediated. Hence, the notion of indirectness is inherent in the concept of mediation.

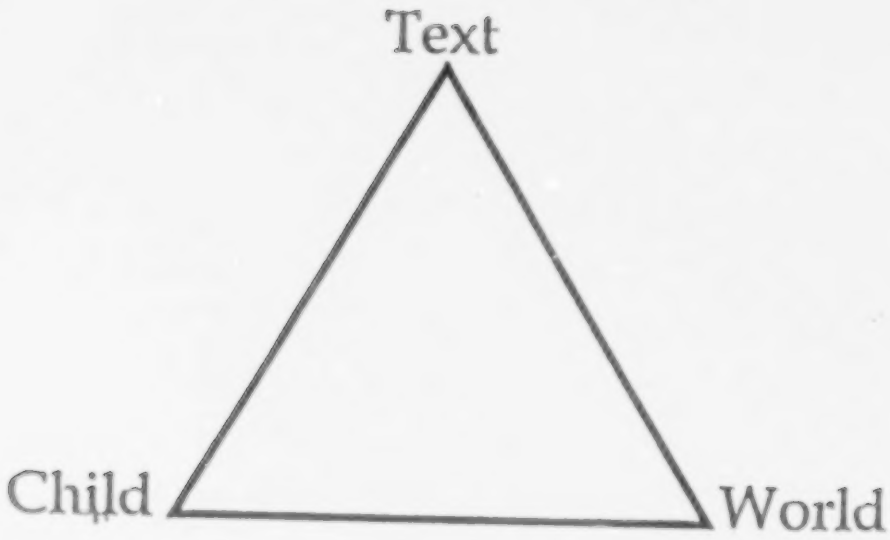

Figure 2. The basic structure of activity mediated by print. The child constructs an interpretation of the world through two routes, one "direct" (child—world) and one "indirect" (child—text—world).

of behavior in two ways that complement their conceptual/material nature. They act simultaneously as tool and constraint; in coming to master aspects of the world, children come to master themselves (Luria, 1932; Vygotsky, 1978).

While the static image of a triangle providing both direct and indirect sources of knowledge represents the dual sources of knowledge, it under-represents the fact that it is only at rare moments that the "culturally" given and the "directly" given coincide completely to determine the "behaviorally taken." Hence my colleagues and I like to draw the basic mediational triangle as in Figure 3. This figure emphasizes both the dual nature of

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Insert Figure 3

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culturally mediated activity and the ineluctable discrepancies that exist between competing sources of knowledge requiring a constant, active process of synthesis out of which behavior emerges. I think of this synthesizing activity as the core of consciousness.

This basic triangular schema, while useful as a specification of minimal structural constraints on adult cognition, needs to be supplemented in several ways in elaborating the cultural consititution of development. First of all, it represents adult consciousness, not that of a newborn, and hence we have to understand how it develops. Second, while artifact creation and artifact mediation are central to culture, culture is not a random assemblage of such artifacts. As Geertz (1973, p. 363) put the

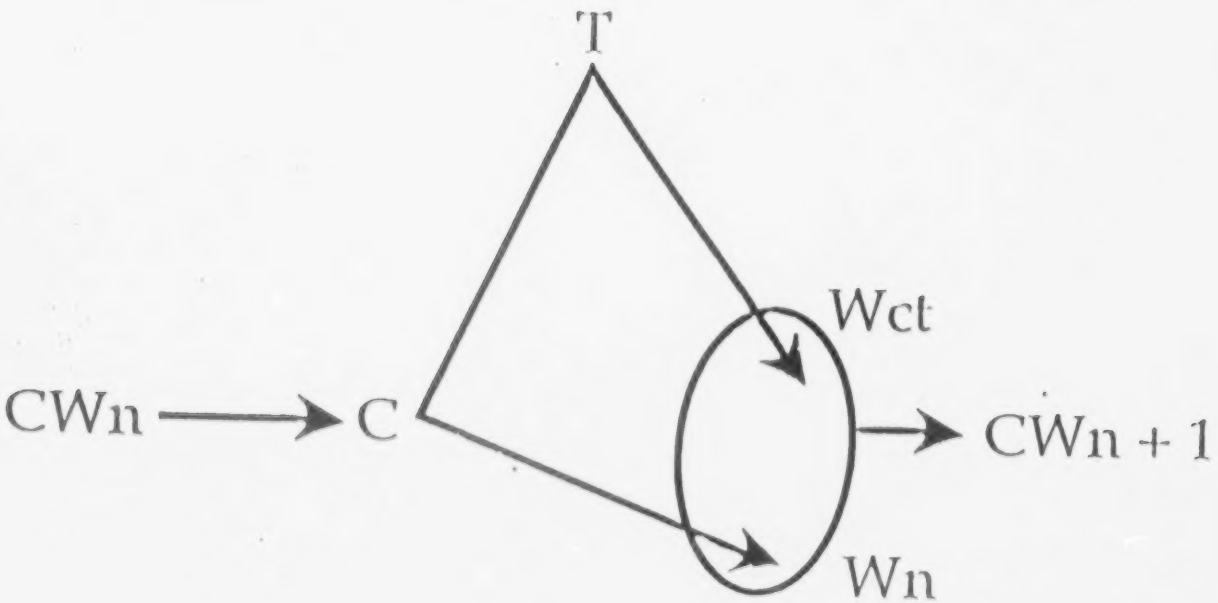

Figure 3. The basic mediated structure of human activity. This application is for interpretation of the act of reading as described in Cole, 1990.

matter, "It is through culture patterns, ordered clusters of signficant symbols, that man makes sense of the events through which he lives." Charles Super (1987, p, 5) makes the same point when he comments that

> Rarely in the developmental sciences...does theory acknowledge that environments have their own structure and internal rules of operation, and thus, that what the environment contributes to development is not only isolated, unidimensional pushs and pulls but also structure.

Hence it is essential to say something about the matter of the structuring of artifacts if one is to elaborate a cultural theory of development. In this paper I will focus on two complementary sources of such structuration which make contact with active areas of discussion among developmental psychologists.[3] The first is indexed by the concept of context, which I think of as a cultural "organizing up" unit. The second is modularity, a plausible candidate for a phylogenetic "organizing up" contributor to development. After discussing each of these concepts separately, I will turn to examine how the two sources of structure are interwoven over time.

Context

[3] Readers familiar with contemporary sociological theories of action will readily recognize here a close affinity between the views about mediation derived from the writings of the cultural-historical school that I am expressing and those of Anthony Giddens (1984). For example, Giddens writes, "According to the notion of the duality of structure, the structural properties of social systems are both medium and outcome of the practices they recursively organize...Structure is not to be equated with constraint but is always both constraining and enabling (p. 25).

A great deal of ink has been spilled over competing conceptions of context among scholars generally interested in socio-cultural theories of human nature (See, for example, the excellent discussions in Goodwin & Duranti, in press). Although the discussion is multidimensional and multidisciplinary, two poorly differentiated issues seem to organize the debate. First, is it acceptable to reduce "context" to "the environment" (from the Latin, "that which surrounds.")? Second, assuming that one differentiates between context and "the environment" how is one to relate culture to context and "that which surrounds?" Of special importance here is the question of the extent to which human beings shape the contexts (and environments) they inhabit: In so far as humans have created the conditions of their existence, context is as much produced as received (Lave, 1988).

My introduction to these issues began in the 1960's as part of a research project attempting to understand the sense in which there are cultural variations in cognitive development. In this work my colleagues and I spoke of psychological tasks and their contexts, very much in the way one would think it reasonable to identify a text and separate it from that which surrounds it, e.g., its **with/con-text**. Transposed to the domain of psychological research on cognitive processes, this notion of context was used to designate the conditions (including the content and social organization) in which a pre-scribed psychological task is presented (Cole, Gay, Glick, and Sharp, 1971). In that work, we demonstrated that by changing the content and procedures of

testing, it was possible to modify significantly the cognitive performance of non-literate African adults. Our discovery that in many, but not all cases, it is possible to demonstrate the presence of presumably absent cognitive abilities (logical remembering, inference, etc.) by such "context manipulations" led us to emphasize the "context- specificity" of thought processes.

As our work progressed, we began to look more and more carefully at the ways in which the tasks we presented fit with culturally organized activities as they were structured and created in everyday practice. We also sought to specify the importance of links between contexts and emphasized the role of mediational means in affording different qualities of activity in different institutional settings(LCHC, 1983).

This way of thinking about context, as a quality of embeddedness, is linked to its use in the study of language in a way that I find illuminating in attempting to understand the relation of context cognitive development. For example, in one of his discussions of context, Gregory Bateson points out that

> A phoneme exists as such only in combination with other phonemes which make up a word. The word is the context of the phoneme. But the word only exists as such -- only has "meaning"--in the larger context of the utterance, which again has meaning only in a relationship.
>
> This hierarchy of contexts within contexts is universal for the communicational...aspect of phenomena and drives the scientist always to seek explanation in the ever larger units (1972, p. 402)

This image of a unit "in the middle" that is simultaneously constituted by and constituting of the successively larger levels

of the system is one that has guided a good deal of my thinking about context. It appears, for example, in our attempts to provide a framework for thinking about the education of underrepresented populations in the American school system (Cole, Griffin, and LCHC, 1987). In that case, we took as the "inner core" a teacher-pupil exchange, and tried to represent its successive layers of context (See Figure 4).

Insert Figure 4

Almost precisely the same image can be found on the cover of Jaan Valsinar's book, **Culture and the Development of Children's Action** 1987), which uses the notions of zone of free movement, zone of promoted action, and zone of proximal development as a set of embedded systems, with face to face interaction between parent and responsible adult at itsits core. It fits too, with Whiting and Edwards' (1988) periodization of childhood (borrowed from Margaret Mead) as proceeding from lap children to knee children to yard children to community children.

The dominant pattern in this metaphor is the circle, a closed synchronically defined unit, but it should be noted that both in the visualizations from the LCHC and Valsiner monographs there is a subimage which disrupts the circle and implies motion. In the LCHC image, it is something like the arrow of time; in the image on the cover of Valsiner's monograph there are children of different ages and sexes (perhaps the oldest are adults), walking somewhere. I believe that this sub-image is important because it

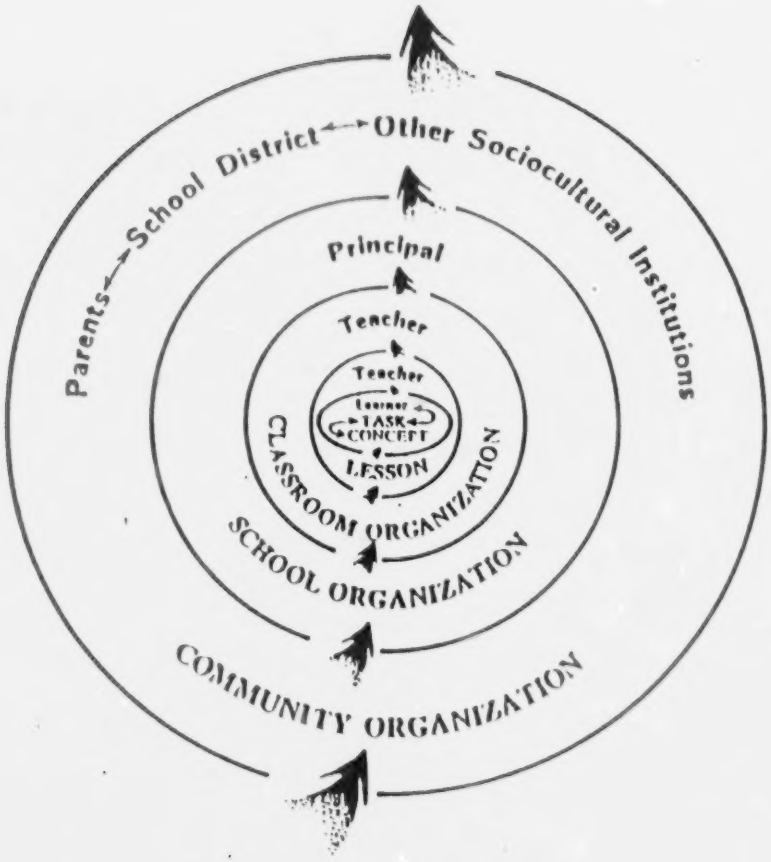

Figure 4 Embedded Contexts.

Figure 4. An application of the notion of context to thinking about the organization of educational activity. From Cole, Griffin and LCHC, 1987

reminds us that the circles are not really closed; they are loosely knit systems of constraints/resources on the behavior or real individuals in real time. There needs to be, as Alexander Luria (1932) argued so many years ago, **time** in the unit of analysis.

In attempting think about this time dimension simultaneously with the embedded contexts representation, I am helped greatly in my thinking by a fascinating convergence of seemingly very different investigators on a common metaphor, the metaphor of"context as a rope." Two examples make the point:

Behavioral ecologists Barker and Wright, impressed with how many different behavior settings children participated in daily are led to remark at the end of their book on the ecology of childhood in a small midwestern town a few decades ago,

> Each of these children was seen to engage in a great many behavior episodes a day]; the number of things a child did in a day, according to our criteria of episodes, varied approximately from 500 to 1,300. ... Most of the episodes did not occur in isolation. Behavior was more often like the interwoven strands of a cord than like a row of blocks in that the molar units often overlapped... Most of the overlapping was a matter of the intersection of the whole of a short episode and a relatively small part of a longer one... The behavior continuum was cord-like,too, in the sense that overlapping episodes often did not terminate at the same time but formed an interwoven merging continuum. (Barker and Wright, 1966, p. 464).

Ray Birdwhistle, a man who has dedicated his career to demonstrating the microgenetic organization of joint activity used almost the same words to define context:

I'll tell you what I like to think about;

> sometimes I like to think of a rope. The fibers that make up the rope are discontinuous; when you twist them together, you don't make them continuous, you make the thread continuous. ... even though it may look in a thread as though each of those particles are going all through it, that isn't the case. That's essentially the descriptive model... Obviously, I am not talking about the environment. I am not talking about inside and outside. I am talking about the conditions of the system. (Birdwhistle and McDermott, 1980, p. 14-15.

These intuitive uses of the term context in terms of the metaphor of a cord/rope/thread are faithful, in an interesting way, to the Latin root of the term, **contexere**, which means "to weave together." A similar sense is given by the Oxford English Dictionary which refers to context as "the connected whole that gives coherence to its parts." Note that according to the notion of context as a rope, context can **not** be reduced to that which surrounds. It is, rather, a qualitative relation between the two analytical entitites (fictions?) that we take as structure and function (the former-- synchronic, the latter-- diachronic). It is, in that sense, "that which weaves together." * It is a view that problematizes the boundaries between "task and its context"
emphasizing that as a general rule, that which is taken as object and that which is taken as that-which-surrounds-the-object are constituted by the very act of naming them.

I will return to pursue this question of metaphors. At this

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* For a philosphical discussion of the affinity between the metaphor of weaving and contextual approaches to human nature see the monograp by Pepper (1943).

point in the discussion, it is sufficient to think of context as a cultural source in the structuration of behavior, which both provides constraints on behavior, the need for active construction by the individual, and tools to be used in that process of construction. Faithful to the metaphor of context as a rope, this source of structuration has important time properties to which I will turn after introducing the third key concept in this paper, modularity.

Modularity

I am not certain of the origins of the concept of modularity, but my own knowledge of it stems from the debate between Piaget and Chomsky (and various commentators) edited by Piatelli-Palmerini (1980). In controverting Piaget's claim that language is constructed on the basis of previously developed sensori-motor schemata, Chomsky argued for the existence of what has come to be called a language module:

> If we really look into the details of the development [of a particular linguistic structure] ... I would expect to find exactly the same thing in the study of any physical organ. The way in which an organ develops is going to depend on all sorts of factors in the environment, but I think that what we would expect to find, and do find over and over again, is that the fundamental organizing properties, the general features, simply are not up for grabs but rather are fixed (1980, p. 176)

In the course of the debate. Jerry Fodor applied the logic of Chomsky's theory of language to cognitive development in general, an argument which he provided an extended treatment of in his book on the modularity of mind (1983).

Simplifying greatly, the Fodor claimed that

1. Pychological processes are domain-specific. The mental operations involved in face recognition are different from those involved in perceiving a musical tune.
2. The psychological principles that organize each domain are innately specified, in a manner similar to that intended by Gesell or Chomsky. They are "triggered" by relevant environmental input, not constructed in the manner suggested by Piagetian theory.
3. Different domains do not interact directly; each is a separate mental module. Modules are loosely connected through a "central processor" which operates on their outputs.
4. While it is possible to have a theory of the structuring principles within modules, no theory of the central processor is possible because the information it draws upon is both unlimited and totally interconnected.

In the past decade there have been interesting attempts to relate modules to specific central nervous system mechanisms (Allport, 1980; Edelman, 1989) and to various forms of intelligence (Gardner, 1983).

Modularity and Context; some ontogenetic relations

It is an interesting historical fact that theorizing about modular, biologically constrained psychological processes became fashionable in psychology at almost the same time that the idea of contextually, cultural-historically constrained processes came

into fashion. Many reasons can be offered for this "specificity zeitgeist," but perhaps most relevant for purposes of the present discusson was a growing dissatisfaction with the Piagetian research program, especially his claims about stage-like transformations in mental functioning. Although they sought improvements in Piaget's formulations in opposite directions (the context theories looking to the environment, variously conceived while the modularity theorists looked to biology) both approaches shared a common interest in demonstrations that very young children are capable of cognitive performances previously thought impossible on the basis of research conducted within the standard Piagetian perspective prominent in the 1960's and 70's. This literature has been reviewed extensively (Cole and Cole, 1989; Donaldson, 1978; Gelman, 1978; Gelman and Bailargeon, 1983) so I need not repeat the details here. Crudely speaking, those emphasizing context focused on 3-4 year olds, while those emphasizing modularity focused on infants or on exceptional children, who demonstrated apparently wide discrepancies in development across domains (child chess whizzes, or mathematicians, or musicians) (e.g. Feldman, 1980).

The combined results of these varied investigations weave a complex web indeed, but the basic point I wish to make can be illustrated with reference to a single example, the development of causal reasoning.

In claiming that 3-4 year old children had yet to construct true mental operations, Piaget was led to conclude

that they were either indifferent to, or did not understand, basic principles of cause and effect. This conclusion was overturned by a number of studies, such as that conducted by Bullock and Gelman (1979) who demonstrated that under suitably simplified conditions, children as young as 3 years could draw correct causal inferences after observing manipulations of a simple mechanical device. The investigators' care in constructing a suitable environment for involving children in a task that made "human sense" (Donaldson's, 1978, characterization of the kinds of contextual arrangements needed to assess young children's cognitive capacities validly) represented an application of the contextual approach.

The demonstration of causal reasoning in 3-4 year olds and the circumstances controlling its appearance and elaboration in various circumstances fit well with a cultural context approach, but in no way suggest innate constraints on development of causal reasoning. Within a few years, however, Alan Leslie and his colleagues demonstrated that under proper conditions, infants would demonstrate at least rudimentary precursors of the concept of causality at as early an age as they could be tested for (6 months in the work of Leslie and Keeble, 1987). Their demonstration rested on the perception that when a moving objects "bumps into" a stationary object, the first object causes the movement of the second. Their infant subjects demonstrated, by their pattern of looking, that they, like adults, perceived the first object as causing the movement of the second.

Leslie (1986) suggests that such modular abilities "get development off the ground," serving as a template that constrains the development of more advanced causal understanding as the child accumulates real-world experience. In a recent paper, Gelman and Greeno (1989) makes a similar argument for the development of mathematical knowledge.

> The idea is that a skeletal set of principles is available to support the kind of selective attention and learning in the domain characterized by these principles. Initial representations serve as enabling devices. Learning would be exceedingly hard, if not impossible, were there no such conceptual skeletons... (p. 128)

Gelman (in press) generalizes this conclusion to a wide variety of early cognitive accomplishments.

The existence of such modular cognitive "launchers" does not, however, imply, that the forms of a particular cognitive process triggered by environmental input at (say) birth are equivalent to the forms that the same processes assume when they become part of culturally organized functional system of action in later life. As Karmiloff-Smith (1989, p. 273) puts it, accepting the modularity position "with respect to **initial** human development does not necessarily preclude a constructivist position with respect to **subsequent** development..." Adults and children alike are subject to the illustion of causality using the procedures employed by Leslie and Keeble, but adults engage in varieties of causal reasoning that are completely outside of the possible experience of newborns.

A schematic summary- so far

One way of representing how the kinds of contextual constraints embodied in procedures that make "human sense" might complement the modular constraints studied by Leslie and others, is given in the contrast between Figures 5a and 5b.

Insert Figure 5 about here

The left hand side of the figure (5a) illustrates in simplified form Fodor's view of modules as input transducers which operate in parallel and whose outputs are fed into a central processor that operates on them. We might call this the "pure modularity" view. The right hand side of the figure (5b) places between the output of the modules and the central processor a level of organization roughly equivalent to cultural context, which selectively recruits different kinds of modular inputs depending upon culturally accumulated knowledge which acts as constraints. According to this (as yet incomplete) view, a primary level of constraint on mind (and development) is provided by phylogenetic modules, whose action is further constrained by historically accumulated modes of action.

Context and culture

In a very simple fashion, Figure 5b seems to represent the sort of view suggested by Gelman and Greeno. In my view, this picture has to be elaborated in at least two ways to capture the complex relations between modular and contextual processes that I believe characterize human development. At the core of these elaboration is the need to take into account the **temporal**

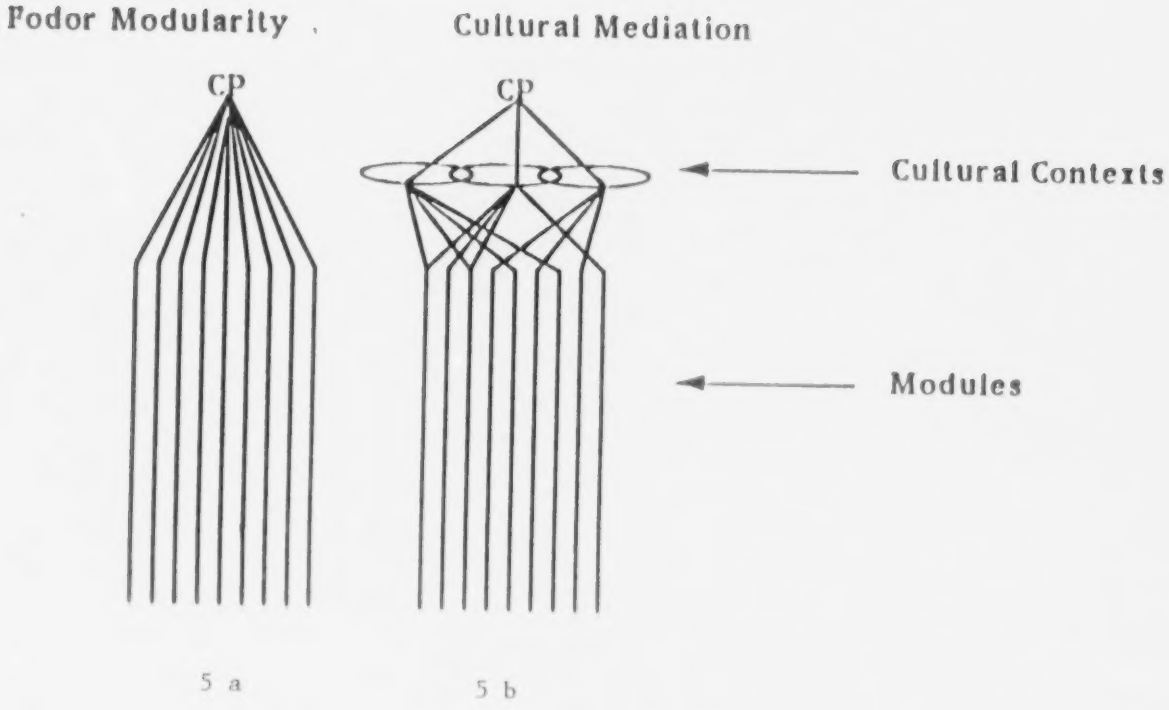

Figure 5. A schematic representation of the modular viewpoint put forward by Fodor (1983) and a preliminary addition of constraints from cultural context.

relations between the two forms of structuration and not be seduced into thinking that "first comes the phylogenetic input, then the cultural modifications." Instead, we must take seriously the co-evolution, both in micro-time and macro-time of phylogeny and culture, as well as the special laws of development appropriate to each.

It is fairly clear that the genetic constraints, inherited from prior generations, are "there at the beginning" in the form of a code contained in DNA molecules. And we know that the particular genetic code inherited at birth operates as part of the process of Darwinian evolution, a process which works by the random production of variation followed by natural selection.

When we turn to consider cultural constraints on development, we are dealing with a very different kind of code and a different mechanism of evolution.

First, as I emphasized earlier, the stuff which carries the cultural code of a human group is not exclusively biological; it is composed of artifacts. These artifacts exist in the present because they have successfully mediated purposeful human interactions with the environment and other people in the past, and in this sense represent distilled, successful modes of adaptation.

As Stephen J. Gould (1987, p. 70) points out,

> Human cultural evolution proceeds along paths outstandingly different from the ways of genetic change. Biologists believe that genetic change is primarily Darwinian-- that is, it occurs via natural selection acting on undirected variation. Human cultural evolution is Lamarckian--the useful

> discoveries of one generation are passed directly to offspring... The processes are different, even though cultural evolution has a biological base.

Second, because the artifacts that mediate human interactions with the environment are simultaneously symbolic and material, it is possible for human beings to project prior successful adaptations into the (imagined) future and then embody them as material constraints in the present. This uniquely human form of constraints on development, and the way behavior within them is socially organized is beautifully illustrated by the work of pediatrician Aiden Macfarlane (1977) who published several transcripts of the reactions of parents when they first catch site of their newborn child and discover its sex (Macfarlane, 1977). Typical examples include such comments as "I shall be worried to death when she's eighteen" or " It can't play rugby" (said of another girl). In each of these examples, the adults interpret the biological characteristics of the child in terms of their own past (cultural) experience. In the experience of English men and women living in the mid-20th century it could be considered "common knowledge" that girls do not play rugby and that when they enter adolescence they will be the object of boys' sexual attention, putting them at various kinds of risk. Using this information derived from their cultural past and assuming that the world will be very much for their daughter as it has been for them, they project a probable future for the child (She will be sought after by males as a sexual partner causing him anxiety. She will not participate in a form of activity (rugby)

requiring strength and agility that is the special preserve of males).

Of crucial importance to understanding the contribution of culture in constituting development is the fact that the parents' projection of their children's **future** becomes a fundamentally important cultural constraint organizing the child's life experiences in the **present**, because, as copius research has demonstrated, even adults totally ignorant of the real gender of a newborn will treat it quite differently depending upon its symbolic/cultural "gender." Adults literally create different material forms of interaction based on conceptions of the world provided by their cultural experience by, for example, bouncing "boy" infants (those wearing blue diapers) and attributing "manly" virtues to them while they treat "girl" infants (those wearing pink diapers) in a gentle manner (Rubin, Provezano, & Luria, 1974).

Macfarlane's simple example also demonstrates an important distinction between the social and the cultural, which are conflated in "two factor" theories of development, including those which seek to parse the environment into social and physical factors. It also motivates the special emphasis placed on the social origins of higher psychological functions by cultural psychologists (Cole, 1988; Rogoff, 1989, Vygotsky, 1989; Wertsch, 1985). As Macfarlane's transcripts clearly demonstrate, human nature is social in a sense different from the sociability of other species because only a culture-using human being can "reach

into" the cultural past, project it into the future, and then "carry" that (purely conceptual) future "back" into the present in the shape of beliefs which then constrain and organize the present socio-cultural environment of the newcomer.

The relations between social and cultural factors in development in terms of Macfarlane's example are represented in Figure 6a and 6b.

Figure 6a,b about here

Figure 6a presents five time lines, the bottom four of which correspond to the three "developmental domains" (Wertsch, 1985) that, according to the cultural framework espoused here, simultaneously serve as major constraints for human development. At the top of the figure is what might be called "physical time," or the history of the universe that long precedes the appearance of life on earth. The second line represents phylogenetic time, the history of life on earth. The third represents cultural-historical time, which co-evolved with phylogenetic time. The fourth line represents ontogeny, the history of a single human being, and the fifth line represents the moment-to-moment time of lived human experience. Four kinds of genesis: phylogenesis, culturogenesis, ontogenesis, and microgenesis, each "lower" level embedded in the level "above it."

What Macfarlane's example forces upon is the need to keep in mind that not one but **two** ontogenies must be represented in place

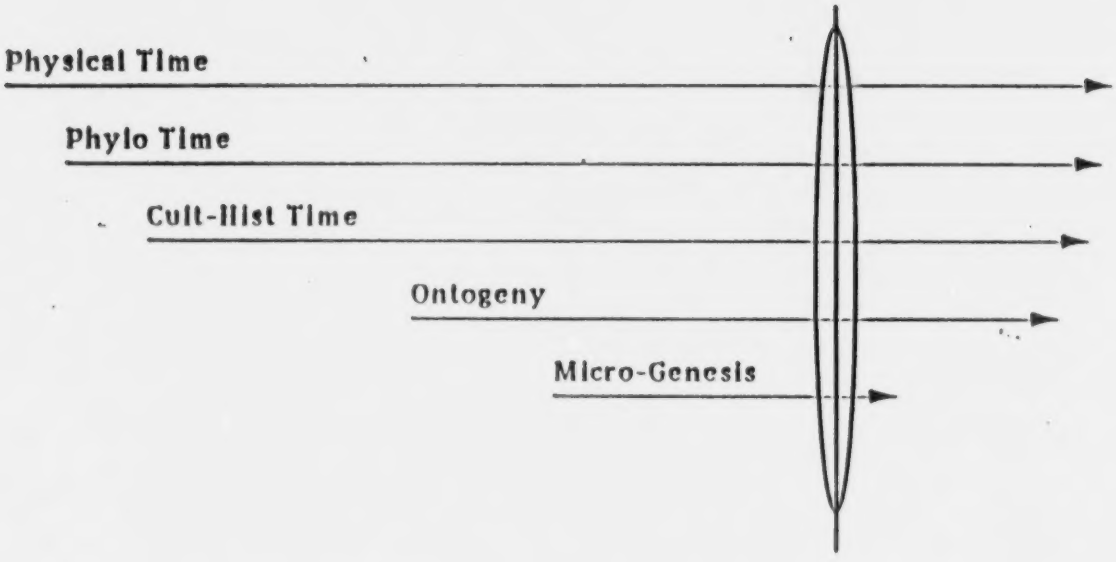

Figure 6a. Different time scales simultaneously operative in the organization of human development. The elipse indicates the context of the birth of a child.

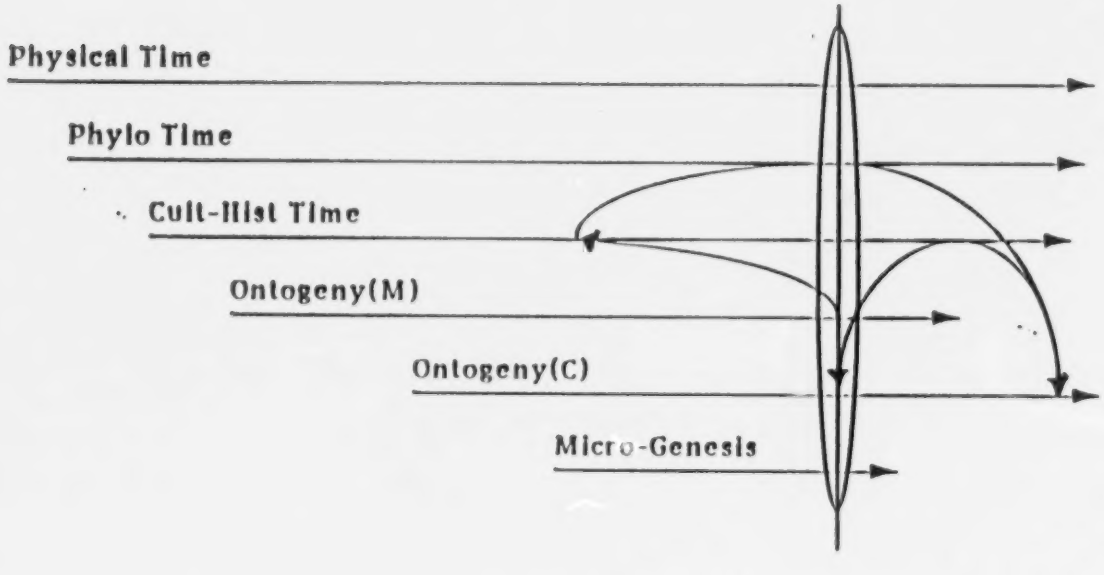

Figure 6b. Different time scales with ontogeny of mother added and arrows indicating the cultural origins and social organization of the child's context of birth.

of the single ontogeny in Figure 6. That is, at a minimum one needs a mother and a child, a social context, for the process of birth to occur and for development to proceed. These two ontogenies are coordinated in time by the simultaneous structuration provided by phylogeny and culture (Figure 5b).

You've gotta have Wa

The process illustrated by Macfarlane and depicted in Figure 6 is not an exception, it is the rule, and it operates throughout development. It shows on the one hand a crucial way in which culture provides essential constraints on development and on the other hand, the social promotion of the development in dynamic inter-relationship to each other. A second example of same principles at a somewhat older age levels experienced during the lifetime of an individual can be seen by comparing the organization of preschool classrooms in the United States and Japan (Tobin, Wu, and Davidson, 1989) and showing how the way adults structure preschool programs embodies their image of the children's future life predicaments.

To start with the preschool level: When Joseph Tobin and his colleagues videotaped a day in the life of a Japanese preschool young Hiroki was acting up. He greeted the visitors by exposing his penis and waving it at them. He initiated fights, disrupted other children's games, and made obscene comments.

When American preschool teachers observed the videotape they disapproved of Hiroki's behavior, his teacher's handling

of it, and of many aspects of life in the Japanese classroom, in general. Starting with the overall ambience of the classroom, Americans were scandalized by the fact that there were 30 preschoolers and only one teacher in the classroom. How could this be possible in an affluent country like Japan? The Japanese had a very different interpretation. First, while teachers acknowledged that it would be very pleasant for them to have a smaller classroom, they believed it would be bad for the children, who "need to have the experience of being in a large group in order to learn to relate to lots of children in lots of kinds of situations." When asked about their ideal notion of class size, the Japanese teachers generally named 15 or more students per teacher in contrast with 4-8 students that represent American preschool teachers' ideal. When Japanese preschool teachers observed a tape of an American preschool they worried for the children. "A class that size seems kind of sad and underpopulated" one remarked. Another added, "I wonder how you teach a child to become a member of a group in a class that small."

There are many interesting implications to be drawn from these observations, only a tiny fraction of which I have touched on here. However, for present purpsoes I want to relate them to the situation such children will encounter when they become adults, in particular the situation that Japanese boys will face should they pursue a career in the "American pastime," baseball.

My source in this case is a fascinating account of the fate of American baseball players who play in the Japanese major leagues (Whiting, 1989). Despite their great skill, experience, and physical size, American ballplayers generally have a very difficult time in Japan. There are many reasons for their difficulties, but crucial is a completely different understanding of keys to success in this team sport differentiating Japanese from Americans, a difference that mirrors differences in preschool education in the two cultures to an amazing degree. The title of the book, "You gotta have wa," pinpoints one key difference. "Wa" is the Japanese word for group harmony, and according to Whiting, it is what "most dramatically differentiates Japanese baseball from the American game (p. 70). While American ballplayers maintain that individual initiative and innate ability are the key ingredients to success, the Japanese emphasize that "the individual was nothing without others and that even the most talented people need constant direction (p. 70)." Despite their acknowledged talent, American players, are generally unable to submit to the Japanese way of doing things.

Here again we see an example where culture operating on young children exerts an effect that is conditioned not so much by present necessity, but by deep, continuous, beliefs about "how things work that make just that way of doing things, "the right way." Taken individually, moment by moment variations in the way adults organize "normal behavior" in their children may seem to

have relatively minor consequences in the present life of the child. But in so far as those beliefs and those ways of doing things "normally" assume different cultural images of the future, they exert major effects in terms of the long term organization of the children's development behavior through the retrospective "bringing back" future cultural constraints into the present by older members of the culture.

The tangled web

Before closing I want to examine modularity/context relationships in yet a larger time perspective than that afforded by the previous discussion, in particular, the way in which module-like biological and context-like cultural "threads" have been woven together over the course of evolutionary history. Such an examination is necessary to understand because it forces one to realize both how thoroughly interwoven biological and cultural evolution are in the constitution of a human being, and helps us to avoid oversimplified notions of the temporal relations that exist between modular and contextual constraints in micro time.

It is helpful to return for just a moment to consider the schematic representations of a modularity and modularity + cultural context constraint approach pictured in Figure 4. There we can see that there is, in micro-time, an apparent two stage process intervening between environment and anything approaching a central processing mechanism: first the input is transduced, then

patterns of transduced input are organized "through culture" as the stuff upon which the central processor does its work.

Turning from this imagined micro-process to the enormous timespan of human phylogeny, a similar "two step" process was long ago proposed by students of human evolution. For example, in his classic article on "the superorganic," anthropologist, Alfred Kroeber (1917) suggests a process whereby, through organic evolution, a new organism comes into being, one with properties such as those described by Leslie White in the passages quoted above, after which the extra- somatic transmission of culture breaks loose of foundation. He pictured this process as shown in Figure 7.

Insert Figure 7 about here

In an equally influential article written half a century later, Clifford Geertz (1973) examined the mounting evidence that the human body, and most especially the human brain, underwent a long (perhaps 3 million year) co-evolution with the basic ability to create and use artifacts. Geertz is led to conclude that

> ...man's nervous system does not merely enable him to acquire culture, it positively demands that he do so if it is going to function at all. Rather than culture acting only to supplement, develop, and extend organically based capacities logically and genetically prior to it, it would seem to be ingredient to those capacities themselves. A cultureless human being would probably turn out to be not an intrinsically

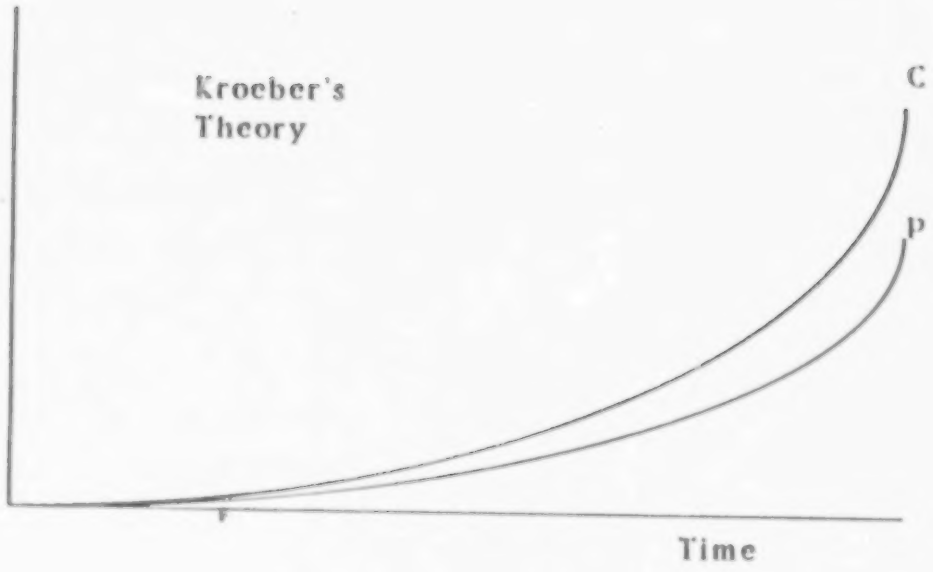

Figure 7. Alfred Kroeber's conception of culture as a superorganic level of organization.

> talented, though unfulfilled ape, but a wholly mindless and consequently unworkable monstrosity. (p. 68)

Hence, instead of Kroeber's picture of culture "lifting off" into the realm of the superorganic, we get a picture of the organic and the artifactual mutually constituting each other over the course of human evolution (Figure 8).

Insert Figure 8 about here

When we think of the process of co-evolution not as the intertwining of two lines, but the intermingling of threads from two "ropes" constituted of principallly different material substances, we are forced to the corresponding relations of phylogenetic and cultural constraints in the micro-development of mind. In particular, it suggests that cultural/contextual constraints and phylogentic/modular constraints are not sequenced in the way implied by Figures 5a&b. Instead, what we need is a way to represent the fact that in phylogeny, in history, and in the microgenesis of mind on a moment by moment basis, the source of constraint which we have labelled as context has been thoroughly inter-mingled with the (phylogeneticaly constrained) input modules. I have attempted to depict this idea in Figure 9.

Insert Figure 9 about here

If indeed this conception of the intertwining of cultural and biological sources of development is correct, and I think it

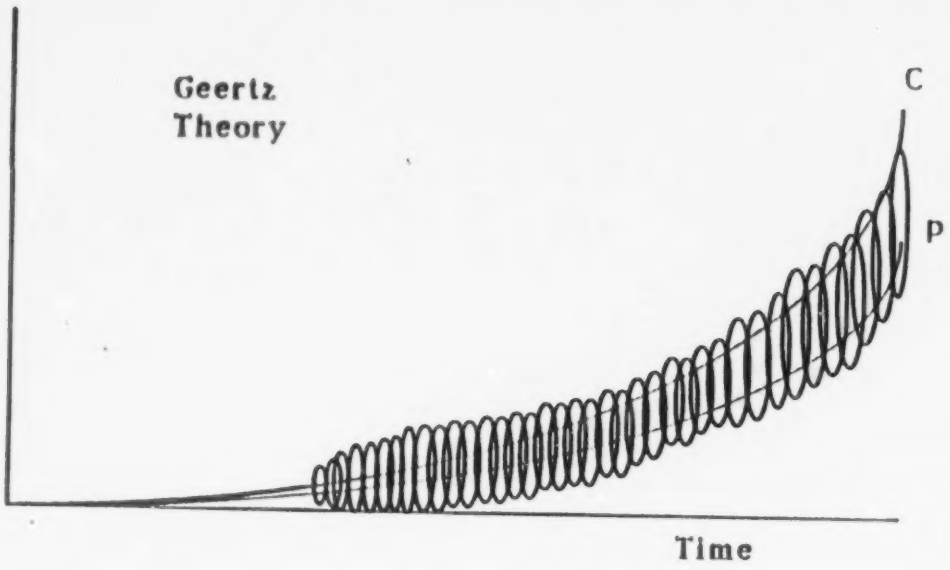

Figure 8. An initial stab at illustrating Clifford Geertz' claim that cultural mediation and phylogenetic evolution co-evolved such that the cultural is interwoven with the biological

Interpenetration of Cultural Mediation and Modularity

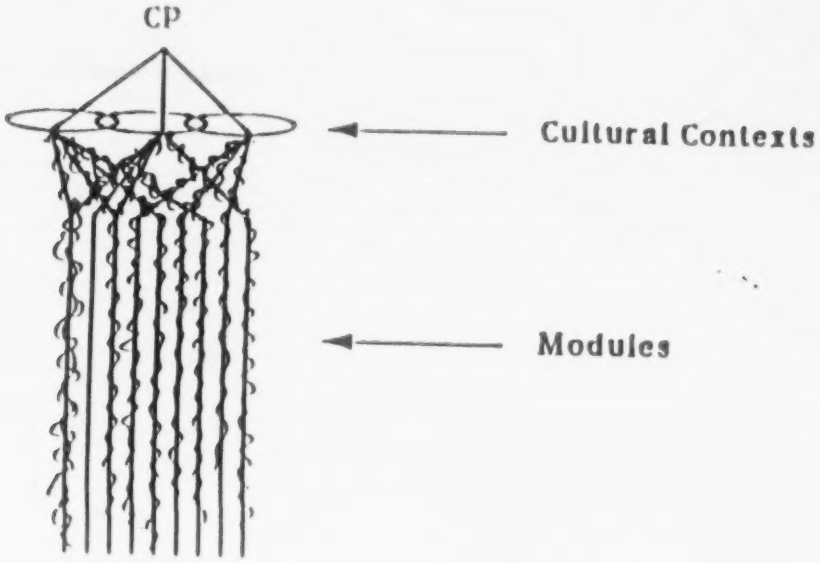

Figure 9. A first attempt to represent the relations between modules and cultural contexts assuming co-evolution of culture and human phylogeny, such that modules and cultural contexts are seen to be mutually constitutive.

is, it helps to explain why it has been so difficult to reach agreement about fundamental issues in developmental psychology. I can at least sketch out here how one fundamental issue disputed by adherents to the classic,"two sided" schools of developmental psychogy, the issue of whether development is stage-like or continuous, might be rethought.

As soon as one adopts the view that cultural and biological processes mutually constritute each other, it becomes clear that both cultural-history and phylogeny contribute both sources of continuity and discontinuity in the organization of development. To take a well documented example, on the biological side, maturation of central nervous system structures such as those which reorganize life at about 2 1/2 months of age operates as a source of discontinuity. Infants sharply increased visual acuity both changes the sources of stimulation they can experience and evokes reciprocal changes from the social environment such that, for example, a qualitatively new form of smiling arises. At the same time bias filters of the kind associated with the term, "temperament" are a source of continuity that span years. Note, however, that in the short time period around 2 1/2 months, there is no detectable ordering of the sort "change in brain state--> change in behavior. Changes in the different spheres seemed to be all jumbled up. And note too that in the temperament studies, the relationships while often striking in individual cases generate relatively low correlation coefficients. This sort of "softness"

in the data suggests that the interactions which produce the observed relations cannot be ordered in a simple linear sequence; we need an approach that simultaneously takes into account heterochrony and heterogeneity as constitutive of the developmental process.

Similarly, there are ways in which culture contributes to both continuity and discontinuity in individual development. In periods of ecological and social stability, culture acts as a powerful source of continuity through the mechanism specified in the birth conversations recorded by Macfarlane. Here it is worth recalling White's telling image, that temporally, the culturally constituted mind "is not a succession of disconnected episodes, but a continuum extending to infinity in both directions, from eternity to eternity." That continuum exists on the foundation that the way things were are the way they are going to be: it "projects" the past into the future, providing the essential basis of psychological continuity. In Geertz' terms, our brains positively demand culture.

However, the invention of new ways to exploit energy or new media of representation, or simple changes in custom, may sufficiently disrupt the existing cultural order to be a source of significant developmental discontinuity. As but a single example, an American mother who assumed that her daughter would not be a soccer player at the age of 16 would have been correct, if the birth took place in 1950. But in 1980, at least in my home town, a

great many American girls play soccer.

Similar remarks obviously apply to the heterogeneity of behavior in a single individual moving from one context to another in a brief period of time, which greatly complicates the problem of characterizing stages of development. Such stages can no longer be located entirely "in" individuals, but in the complex interactions between biological and socio-cultural contributions to the constitution of persons over time.

Qualities of mind

I hope it is clear by my invocation of the Latin derivation of context, that I do not consider the ideas presented here to be original. They are merely my own construction of insights that have often been remarked upon in those patches of human culture with which I am familiar. In my own case, the emerging picture of a dynamic, interacting system that is life and mind has been particularly influenced by Alexander Luria, who likened mind to a "non-accidental mosaic" (Luria, 1932). Luria himself was influenced by William James, whose meditations on the structure of human consciousness are a fitting end to my remarks. The following passage, attributed to James, summarizes almost perfectly the qualities of mind that one expects in pursuing the developmental

approach that I have attempted to explicate here.[5]

> The world is full of partial stories that run parallel to one another, beginning and ending at odd times. They mutually interlace and interfere at points, but we cannot unite them completely in our minds... It is easy to see the world's history pluralistically, as a rope of which each fibre tells a separate tale; but to conceive of each cross-section of the rope as an absolutely single fact, and to sum the whole longitudinal series into one being living an undivided life is harder. The great world's ingredients so far as they are beings, seem, like the rope's fibers, to be discontinuous, cross-wise, and to cohere only in the longitudinal direction. Followed in that direction, they are many.

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[5] I ran across this passage several years ago in an English anthology in which it was attributed to James's **A Pluralistic Universe**. However, while the passage is perfectly consistent with the ideas that James expresses in that text, I have unable to locate it there, or elsewhere in James' writings. I would be grateful to any reader who can help me locate the proper reference. And if such a reference cannot be found I am perfectly content to take credit for the ideas myself!

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